

Entanglement-assisted Communication System for NASA's Deep-Space Missions: Feasibility Test and Conceptual Design

Completed Technology Project (2011 - 2012)



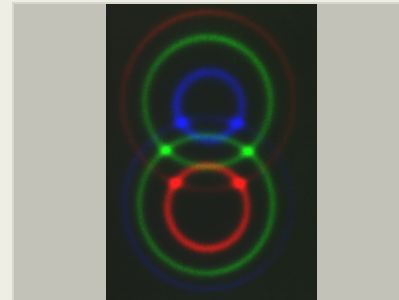
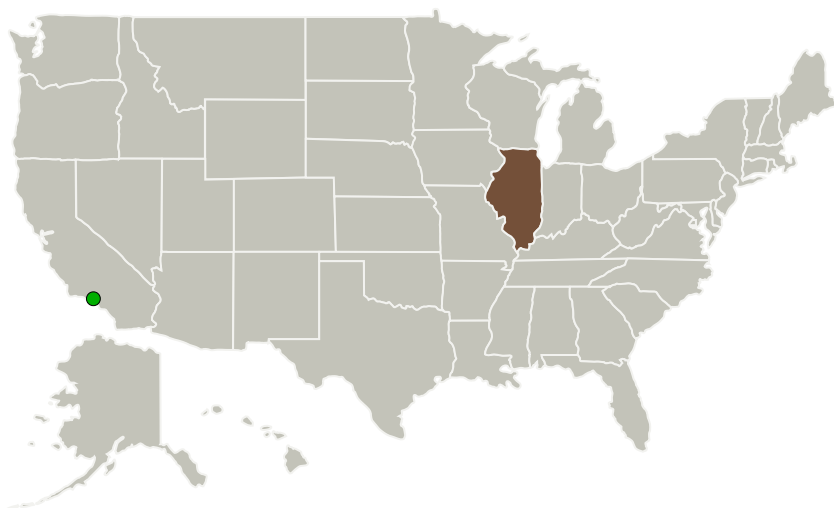
Project Introduction

This project is involved with transferring information through the vast distances of space. The challenge is that it is difficult to get many photons from a transmitter on Earth to a distant satellite or vice versa. Therefore, one wants to be able to store and transmit as many bits of information as possible on each individual photon. This is the eventual goal of this project. In order to achieve this the team will be looking at what benefits can be obtained by using pairs of photons that are "entangled" with each other. Entanglement is the quintessential quantum mechanical phenomenon that describes the bizarre correlations that can exist between two quantum systems that have interacted with each other at some point in the past. The simplest example would be two coins, each of which are equally likely to give heads or tails when flipped, but somehow both always give the same result when flipped. And in reality, quantum entanglement is even a bit weirder than that. In any event, using entanglement may enable faithful transmission of more information per photon than conventional means; the goal is to demonstrate that, and see what the limits are.

Anticipated Benefits

As NASA continues to push into deeper space, and to ever more detailed investigations of our local celestial objects, there is a need for increased communication data rates. This has prompted many investigators to look into what quantum phenomena can offer. Communication at optical wavelengths offers some advantages over radio frequencies due to reduced diffraction.

Primary U.S. Work Locations and Key Partners



Project Image Entanglement-assisted Communication System for NASA's Deep-Space Missions: Feasibility Test and Conceptual Design

Table of Contents

Project Introduction	1
Anticipated Benefits	1
Primary U.S. Work Locations and Key Partners	1
Project Transitions	2
Organizational Responsibility	2
Project Management	2
Technology Maturity (TRL)	2
Images	3
Technology Areas	3
Target Destinations	3

Entanglement-assisted Communication System for NASA's Deep-Space Missions: Feasibility Test and Conceptual Design

Completed Technology Project (2011 - 2012)



Organizations Performing Work	Role	Type	Location
University of Illinois at Urbana-Champaign	Lead Organization	Academia	Urbana, Illinois
Hampshire College	Supporting Organization	Academia	Amherst, Massachusetts
● Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations

Illinois

Project Transitions

▶ **September 2011:** Project Start

✓ **September 2012:** Closed out

Closeout Summary: Our research into quantum communication, and quantum-enhanced classical communication for deep-space applications has had several significant advances. In particular, we performed the first realization quantum superdense teleportation, remotely preparing up to three independent coherent phases. We have also showed that the advantages of superdense coding can sometimes be realized without the use of entanglement; in other cases, only true multipartite entanglement seems to provide an advantage. Finally, we considered some more advanced protocols, with the goal to realize entangled channels that have capabilities beyond the sum of the individual channels; we conclude that more study is needed to identify practical implementations.

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

University of Illinois at Urbana-Champaign

Responsible Program:

NASA Innovative Advanced Concepts

Project Management

Program Director:

Jason E Derleth

Program Manager:

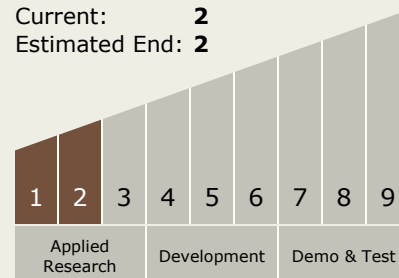
Eric A Eberly

Principal Investigator:

Paul Kwiat

Technology Maturity (TRL)

Start: **1**
Current: **2**
Estimated End: **2**

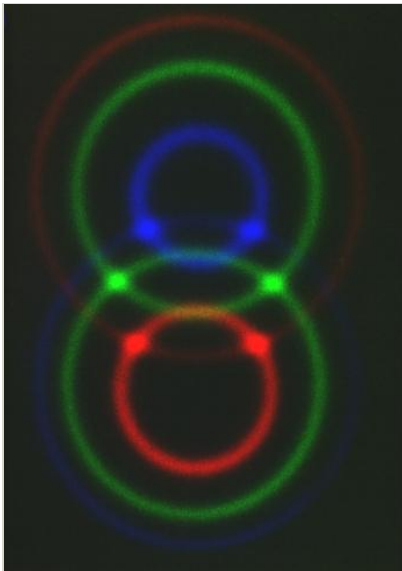


Entanglement-assisted Communication System for NASA's Deep-Space Missions: Feasibility Test and Conceptual Design

Completed Technology Project (2011 - 2012)



Images



15121.jpg

Project Image Entanglement-assisted Communication System for NASA's Deep-Space Missions: Feasibility Test and Conceptual Design

(<https://techport.nasa.gov/image/102181>)

Technology Areas

Primary:

- TX05 Communications, Navigation, and Orbital Debris Tracking and Characterization Systems
 - └ TX05.5 Revolutionary Communications Technologies
 - └ TX05.5.2 Quantum Communications

Target Destinations

Others Inside the Solar System, Foundational Knowledge